The Effect of Temperature on Gravitative Attraction.

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Previous work by one of us* with a torsion balance of the Boys-Cavendish type had appeared to indicate that the so-called Newtonian Constant of Gravitation increases slightly as the attracting bodies are heated. The attempt has now been made to carry the work to a higher order of accuracy with a view to confirming or disproving that result. The clearing up of this point has become of greater importance on account of the recent development in the theories of gravitation.

The same delicate torsion balance was used as in the former experiments. This consisted of a fine quartz fibre carrying a light beam, from which two silver balls were suspended by fibres of unequal length. It was contained in a vacuum tube, and the observations were made by means of a beam of light proceeding from an illuminated scale through a window in the vacuum tube, and reflected by a small plane mirror attached to the torsion fibre. Two lead spheres, each of 100 lbs. weight, were placed near the silver spheres, so that by their attraction first to one side and then to the other, a torsional deflection might be obtained from which to calculate G. These deflections were not determined directly on account of the length of time required for the torsion system to come to rest, but were calculated from observations of successive turning points of the image of the scale.

The most important improvement in the new arrangement was in regard to the methods of suspension, both of the vacuum tube and of the large attracting spheres. Previously, trouble had arisen from disturbing tremors due chiefly to distant railway trains, which made accurate observations of turning points difficult to secure. The aim was to keep out tremors by arranging a suspended system, not too tightly gripped, yet held firmly enough to prevent slight displacements of component parts of the apparatus which would render the results worthless. For this purpose the vacuum tube was suspended from a cranked iron bar, in cantilever fashion, the bar itself being capable of turning about a horizontal axis, but held by steel springs and lead weights, so as to keep the tube vertical. This arrangement formed a "floating system," any lateral displacements in which were prevented by thick pads of indiarubber. Moreover, the floating system was itself suspended from strong angle irons heavily loaded, and resting on steel balls embedded in rubber placed in recesses in the walls of the building. With these dispositions it was found possible, under good working conditions, to estimate the turning points of the moving image of the scale accurately to 0·1 mm. A further improvement was obtained by increasing the distance from mirror to scale to 6 metres. Around the suspended system were wound coils of tubing through which a steady stream of cold water was passed, and this, together with a packing of cotton-wool, maintained the vacuum tube and its contents at a steady temperature.

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* Shaw, 'Phil. Trans.,' A., vol. 216, 1916.

A temperature effect was sought in the differences of the deflections of the balance obtained when the large masses, used first cold, then hot, and then cold again, were moved from an A position to a B position. To give the results of one complete experiment (the whole number of which was eleven)—In millimetres of scale, the mean of seven "cold" deflections was 207·06 (greatest 207·20, least 206·95), and of twelve "hot" deflections 206·98 (greatest 207·15, least 206·85). Thus the mean difference in range was $-0 \cdot 08$ mm., and as this is within the limits of experimental error, the result deduced is that, assuming G does vary according to a law $G = G_0(1+\alpha t)$, then α is at any rate numerically less than $1 \cdot 6 \times 10^{-6}$. Thus, as far as these experiments go, *i.e.*, for a temperature range 0° to 250° C., G remains constant.

This result is in opposition to that of the previous work, and we are of the opinion that slight displacements of the heavy masses occurring during the experiments introduced systematic errors in the former work. In the present experiments we think we have secured the absence of these by firmer support.

We wish to record our obligation to the Royal Society for a grant in aid of this research.